

PATENT SPECIFICATION

1,023,213



DRAWINGS ATTACHED

1,023,213

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COMPLETE SPECIFICATION

A method of Inhibiting the Volatilisation of Volatile Organic Materials

We, OMEGA CHEMICALS CORPORATION, a corporation of the State of Maryland, United States of America, of 3440 Fairfield Road, Baltimore 26, Maryland, United States of America, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the suppression of evaporation or sublimation of volatile organic liquids and solids during storage. The invention is more particularly concerned with adding a small amount of an organic compound to the volatile organic material while storing same, which markedly suppresses the tendency of these volatile organic compounds to evaporate or sublime during storing besides reducing the flammability of these substances. By the term "volatile organic material" as used herein, we mean any organic material, either liquid or solid, which passes easily into the gaseous state by either evaporation or sublimation.

Previously it had been found that certain compounds such as cetyl and stearyl alcohols, which decrease the evaporation of water to some extent, were totally ineffective in decreasing the evaporation and reducing the flammability of volatile organic materials such as benzene, styrene, acetone, or methanol. In fact, those agents have been found to actually increase the evaporation rate of non-polar or organic liquids because of local evaporation and precipitation which gives rise to "wicking"; i.e., increasing the surface area for evaporation of the substrate of volatile organic matter.

Because of the lack of success with chemical additives such as those named above, physical methods have been used by industry to decrease the volatilization of volatile organic materials during storage. Some of these physical methods include the use of a specific design of tanks and containers for holding the volatile organic material, the use of hollow spheres which float in the volatile organic material, and the use of non-compatible; non-volatile liquids which float on the volatile organic material to be protected. All of these methods of reducing the volatility and flammability of organic materials during storage have been fraught with complexity and narrowness of application.

We have found that additive compounds which satisfy certain specific physical properties are effective in inhibiting evaporation and ignition and flammability of highly volatile organic liquids such as benzene, styrene, acetone, methanol, ethanol, isopropanol, diethyl ether, carbon disulfide, gasolines, alkanes and chloroalkanes,

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aromatic medicinal oils such as oil of wintergreen and oil of cloves, and solids such as p-dichlorobenzene, solid carbon dioxide and naphthalene during storage.

By use of these additive compounds it is possible to decrease the rate of sublimation of moth repellants so as to improve their shelf stability, to remove the disagreeable odors of volatile organic liquids, to mechanically control the rate of the evaporation of refrigerants in order to provide a method of controlling cooling systems, and to reduce pre-ignition of gasoline in internal combustion engines, thereby eliminating such problems as smog and polymerization of the aldehydes in the gasoline engine. It has been found that these and other advantages have been obtained by use of these additives to volatile organic materials.

An object of this invention is to provide a method of storing of volatile organic materials.

Another object of this invention is to provide a means to decrease the volatilization of volatile organic materials during storage and to suppress the disagreeable odors of many organic liquids while they are stored and to decrease the flammability of such liquids during storage.

Other objects will become apparent from the accompanying drawings and from the following detailed description in which it is intended to illustrate the applicability of the invention without thereby limiting its scope to less than that of all equivalents which will be apparent to one skilled in the art.

In the accompanying drawings:

Figure 1 is a graph showing the evaporation curves for a solution of benzene containing varying amounts of sorbitan mono stearate;

Figure 2 is a graph showing the evaporation curves for a solution of benzene containing varying amounts of dodecylurea-N¹-glucoside;

Figure 3 is a graph showing the evaporation curves for a solution of benzene containing varying amounts of dihydroascorbyl stearate.

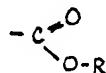
We have discovered that by adding to a volatile organic material from .005% to 10% by weight of the organic material of an organic compound having the specific molecular structure described hereinafter, the volatilization and flammability of the organic material will be inhibited and other objects will be achieved as a result of the molecular structure of this compound.

Our invention therefore is based on the discovery that a certain molecular structure will inhibit the evaporation or sublimation and thus the flammability of volatile organic compounds so as to allow these volatile organic compounds to be stored and used more easily. This discovery is predicated on the specific molecular structure which decreases the evaporation and flammability of volatile organic materials.

A molecule of an organic compound used according to our invention comprises a cyclic hydrophilic head and a long hydrophobic tail attached thereto. It is not understood why compounds possessing this structure should demonstrate such outstanding effectiveness in controlling the evaporation rate of organic materials. However it is believed that the following theory may account for their performance. More specifically the compounds which are effective are believed to have three critical parts, namely, at least one head or hydrophilic section (two or more in the case of sucrose or other polysaccharide derivatives), at least one tail or hydrophobic section (one for each head) and an intermediate section (for each head and tail) to which the head and tail are joined.

The head section must contain at least one cyclic organic ring structure, with each ring being composed of from 4 to 8 atoms. The atoms which compose each ring may be all carbon atoms, but preferably the ring is heterocyclic and will contain one or more oxygen atoms, or one or more nitrogen atoms or one or more sulphur atoms. It is believed desirable, as a matter of theory, that the heterocyclic atoms within the ring of the head or the other hydrophilic groups attached directly to the head be so distributed about the head that the head would tend to lie in a plane at a hydrophobic-hydrophilic interface. Thus one or more hydrophilic radicals, i.e. (lipophobic or polar groups) preferably is contained in the head; an atom of each such group may in some cases be a ring atom, alternatively such group may be attached to a ring atom directly or through one, two, three or four intermediate atoms. Suitable hydrophilic radicals;

i.e., polar groups, are —OR , $\text{—N}(\text{H})\text{R}$,



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$-\bar{C}-R$, $-\bar{N}=\bar{N}-R$, $-\bar{O}-$, $-\bar{NO}_2$, sulphate, sulfonate, phosphate, phosphonate, mercaptan and thioacid, in which R is $-\bar{H}$ or a saturated or unsaturated hydrocarbon radical containing from 1-5 carbon atoms. We believe that the head is preferably substantially parallel to the plane defined by the surface of the organic volatile material by reason of the distribution of hydrophilic groups in or about the head.

The hydrophobic tail or stem of the molecule must be joined to the hydrophilic head so that the tail can take a position approximately perpendicular to the plane defined by the ring structure of the head and we believe as a matter of theory that the tail extends downward into the volatile organic material from the plane of the ring in the head of the molecule, and is substantially entirely underneath the head, but do not wish to be limited by such theory.

The tail comprises aliphatic radicals containing from 6 to 30 carbon atoms and having at most two unsaturated bonds. The tail must be hydrophobic or lipophilic and cannot contain polar groups to an extent which destroys the essential hydrophobic nature of the tail. The term "aliphatic radicals" as used in the claims, means predominantly straight chain paraffinic hydrocarbon radicals with or without a moderate amount of cross branching and which may or may not be suitably substituted with chloride or bromide and other atoms and radicals which do not destroy its otherwise described properties, such as at most one $-\text{O}-$ linkage. The preferred halogen that may be substituted on the chain is chlorine. In order for the compound to have the desired properties, it is believed that the average cross-sectional radius of the tail is approximately from 1.6\AA° to 3.2\AA° .

The preferred average cross-sectional radius of the head around a vertical axis extending therethrough is believed to be 6.9 Å and is preferably from 1.2 to 4.3 times the average radius of the tail; otherwise it is believed that the orientation of the molecule tends to be dictated by the tail so as to destroy the property of inhibiting volatilization and inflammability during storage.

The tail and head are joined so that the tail may extend perpendicularly downward from the plane defined by the ring or rings in the head. The group or portion by which the head and tail are joined comprises a chain of 1 to 5 carbon atoms and extends from the bond to which said head is joined to the bond to which said tail is joined. It is believed essential that this linkage provide for the tail being free to rotate with respect to the head and provide for the tail to extend perpendicularly from the plane of the ring in the head without hindrance. Suitable groups which may be in or attached to such linkages for uniting the head and tail in such manner may

include: $\text{---CH}_2\text{---}$, ---O--- , ---C=O--- , ---N--- , ---C(=O)N--- , ---N---C(=O)--- , ---S--- ,

---C---O--- , ---C--- , ---N---C---N--- , sulfate, sulfonate, phosphate and phosphonate.

The phenomena whereby such a structure may inhibit or preclude the volatilization and flammability of volatile organic materials is believed to be as follows: when the additive is added to the volatile organic material the head of the additive selectively migrates to the interface of the volatile material due to the insolubility of the head in the organic material produced by the hydrophilic groups. This causes the plane defined by the ring in the head to lie substantially parallel to the plane of the surface of the volatile organic material so that a protective covering forms over the material, preventing volatile organic material from evaporating or subliming during storage. The tails which are soluble in the organic material due to their hydrophobic or lipophilic nature extend directly into the volatile organic material and substantially perpendicular to the plane defined by the heads. Due to microcrystallization that occurs between hydrocarbon groups of the tails and due to the orientation of the

tails within the volatile organic materials, the tails of the molecules are believed to interact forming a barrier which prevents the interior of the volatile organic material from having access to the surface. Thus, we theorize that a primary factor in inhibiting the volatilization of the organic material is the orientation of the heads and tails, and that it is essential for the ring in the head of the molecule to substantially define a plane which is parallel to the surface of the material so that the heads form a protective covering for the volatile organic material. Thus, any structural group attached to the head which prevents the head from orienting in the manner described will, we believe, destroy the effectiveness of the additive.

In the case of the mono esters of sorbitan which are highly effective as volatilization inhibitors, the reaction of these esters with as little as 3 molecules of ethylene oxide almost completely destroys the effectiveness of the sorbitan ester in inhibiting the volatilization of benzene.

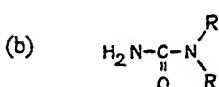
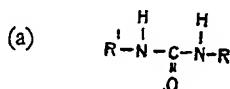
We also theorize that the hydrophobic tail must extend directly into the liquid and must be capable of association bonding within the organic material so as to form a barrier which prevents surface access to the interior of the volatile organic material.

The tail comprises predominantly straight chain aliphatic radicals with or without a moderate amount of cross-branching containing at most two unsaturated bonds and no polar groups which destroy its hydrophobic nature it may contain an unsaturated bond, it may contain an —O— linkage and it may be substituted with chlorine or bromine). If such is not the case, the chains will not be able to bond with other chains within the organic material and small flaws will be present due to the incomplete bonding of the tails of the molecule. These flaws allow access of the interior of the volatile organic material to the surface.

The following specific groups of compounds are among those which fall within the molecular structure necessary to inhibit the evaporation and sublimation of volatile organic materials. In the following compounds the straight chain hydrocarbon preferably has an average cross-sectional radius approximately from 1.6 \AA to 3.2 \AA .

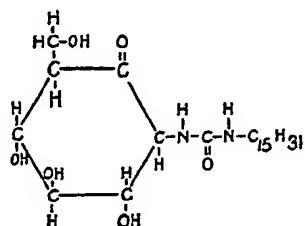
I. Sugar derivatives including both ethers and esters of both mono- and disaccharides of both hexoses and pentoses. Typical compounds are:

A. Alkylurea glucosides represented by the formula:



where R is a higher straight chain hydrocarbon radical having from 6 to 30 carbon atoms containing at most two unsaturated bonds and R' is a monosaccharide or a reducing oligosaccharide.

Typical compounds are:
Pentadecylurea-N-Glucoside

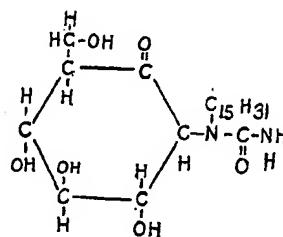


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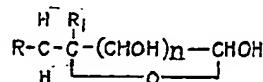
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Pentadecylurea-N¹-glucosides



5 It will be understood that when either a specific alkylurea glucoside or alkylurea glucoside as a class is referred to, both the alpha- and beta-substituted ring forms are intended to be encompassed.

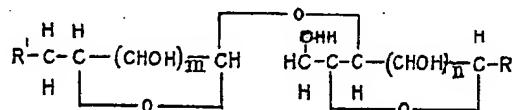
B. Monopyranose esters and ethers, and in particular the glucose ethers as described in U.S. patent 2,974,134. Representative esters and ethers are:



10 in which R in this example may be derived from an alkyl ether containing between 10 6 to 30 carbon atoms and having at most one unsaturated bond or an acid radical of an organic acid containing between 6 to 30 carbon atoms having at most one unsaturated bond and R¹ may be —H, or —OCH₃ and n is an integer in the range of 2 to 4.

15 Typical compounds which fall into this class are: glucose monopalmitate, glucose monostearate, monostearyl glucose, and monopalmityl glucose.

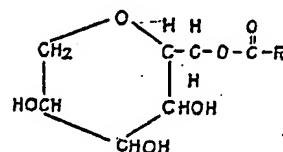
C. Diesters or diethers of disaccharides represented by the formula:



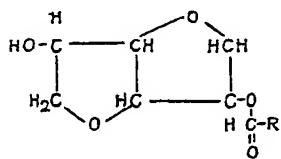
20 (each ring or head portion being monoesterified or monoetherified) wherein m and n in this example are integers ranging from two to four and R and R¹ in this example are selected from the group consisting of monovalent organic acid radicals containing from 20 6—30 carbon atoms and having at most two unsaturated bonds, —H, and monovalent alkyl or ether radicals containing from 6—30 carbon atoms and having at most two unsaturated bonds. Typical compounds which fall within this formula which may be used as the evaporation or sublimation inhibitors of this invention include sucrose distearate, cellobiose distearate, lactose distearate, etc.

25 D. Fatty acid esters of sorbitol dehydration products such as the following:

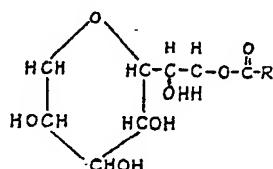
(1)



(2)



(3)



where R is an unsubstituted alkyl radical containing from 6—30 carbon atoms and having at most two unsaturated bonds.

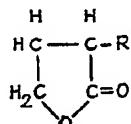
5 E. Ascorbyl and hydrogenated ascorbyl esters such as disclosed in U.S. patent 2,889,227. Typical compounds would be ascorbyl palmitate and ascorbyl stearate.

F. Methyl glucoside fatty acid esters as disclosed in U.S. patent 2,931,797.

G. Derivatives of 5-amino ribofuranose as disclosed in U.S. patent 2,875,194.

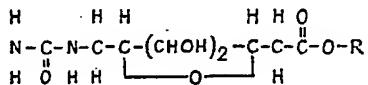
10 II. Substituted rings of from 4—8 atoms having a single heterocyclic atom as oxygen, nitrogen or sulfur and including oxetane, pyrrole, furan, thiophene, piperidine, pyridine, pyran, and thiapyran. Among the compounds falling in this group are included:

A. Substituted lactones such as the butyrolactones having the following formula:



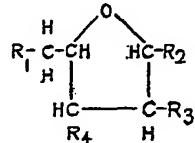
15 wherein R in this case is selected from the group consisting of monovalent alkyl, organic acid and ether radicals having from 6—30 carbon atoms and having at most two unsaturated bonds.

B. Compounds having the following structure:



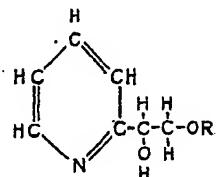
20 wherein R is in this case a straight chain hydrocarbon radical containing 5 to 25 carbon atoms and having at most two unsaturated bonds.

C. Compounds having the following generic formula:



wherein R₁, R₂, R₃ and R₄ in this case are hydrogen, organic acid, ether and straight chain hydrocarbon radicals containing 6—30 carbon atoms and having at most two unsaturated bonds and further characterized in that three of said R₁, R₂, R₃ and R₄ are monovalent hydrogen radicals.

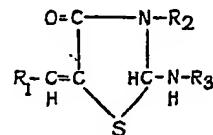
- 5 D. Pyridyl glycol ethers and esters having the generic formula: 5



wherein R in this case is selected from the group consisting of monovalent alkyl radicals and organic acid radicals containing 5—30 carbon atoms and having at most two unsaturated bonds.

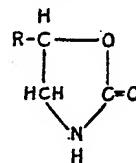
- 10 III. Compounds wherein the substituted ring has from 4—8 atoms including two heterocyclic atoms. Compounds in this group include, without limitation, those having the following ring structures: oxazole, oxazoline, thiazole, oxathiole, dioxolane, imidazole, imidazolidine, pyrazoline, morpholine, and thiazine. Compounds included in this group include, without limitation:

- 15 A. Imidazoline guanylimines, as disclosed in U.S. patent 2,927,922. 15
 B. Oxazolines as disclosed in U.S. patent 2,932,617.
 C. Imidazolines as disclosed in U.S. patent 2,889,334.
 D. Compounds having the following generic formula:



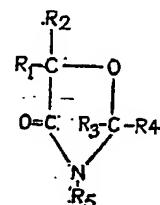
- 20 wherein R₁, R₂ and R₃ in this case are selected from the group consisting of monovalent hydrogen, alkyl, alkyl ether and acid radicals containing at from 6—30 carbon atoms and having at most two unsaturated bonds and further characterized in that two of said R₁, R₂ and R₃ are monovalent hydrogen radicals. 20

- E. Compounds having the following generic formula:



wherein R in this example is selected from the group consisting of monovalent ether radicals, monovalent alkyl radicals, or organic acid radicals containing 6—30 carbon atoms and having at most two unsaturated bonds.

- F. Compounds having the following generic formula:

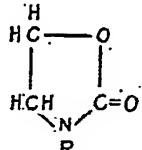


wherein R₁, R₂, R₃ and R₄ in this case are selected from the group consisting of

monovalent alkyl, organic acid and ether radicals containing from 6 to 30 carbon atoms and having at most two unsaturated bonds and R₃ is selected from the group consisting of monovalent hydrogen, alkyl, and organic acid radicals containing at most two unsaturated bonds and further characterized in that four of said R₁, R₂, R₃, R₄ and R₅ are the monovalent hydrogen radical.

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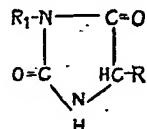
G. Oxazolidines having the following generic formula:



wherein R in this example is selected from the group consisting of monovalent alkyl and organic acid radicals containing from 6—30 carbon atoms and having at most two unsaturated bonds.

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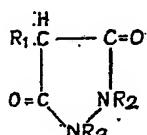
H. Alkyl hydantoins having the following generic formula:



wherein one of R₁ and R in this example is hydrogen and the other is an alkyl radical, an alkyl ether radical, or an organic acid radical having from 6—30 carbon atoms and containing at most two unsaturated bonds.

15

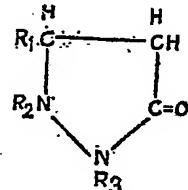
I. Dioxopyrazolidines having the following generic formula:



wherein R₁, R₂ and R₃ in this example are selected from the group consisting of hydrogen, alkyl, organic acid and other radicals containing from 6—30 carbon atoms and having at most two unsaturated bonds, said compound being further characterized in that two of said R₁, R₂ and R₃ are hydrogen.

20

J. Compounds having the following generic formula:

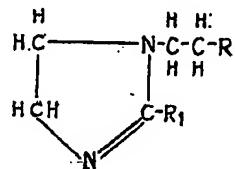


wherein R₁, R₂ and R₃ in this case are selected from the group consisting of hydrogen, alkyl, organic acid and ether radicals containing from 6—30 carbon atoms and having at most two unsaturated bonds and further characterized in that two of said R₁, R₂ and R₃ are hydrogen radicals.

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K. Compounds having the following generic structure:

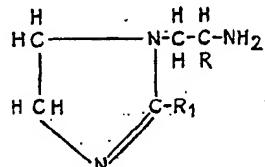


wherein one of R and R₁ is hydrogen and the other is an organic acid, ether or alkyl radical containing from 6—30 carbon atoms and having at most two unsaturated bonds.

5

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L. Compounds having the following generic structure:

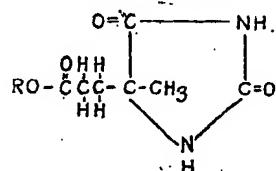


wherein R is selected from the group consisting of alkyl, organic acid and ether radicals having from 6—30 carbon atoms and having at most two unsaturated bonds and R₁ in this case is selected from the group consisting of —H and —OH.

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M. Hydantoins having the generic formula:

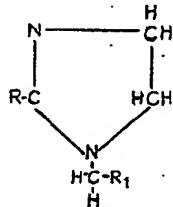


wherein R is an alkyl radical containing 3—29 carbon atoms and having at most two unsaturated bonds.

15

15

N. Compounds having the following generic formula:

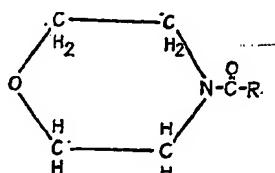


wherein R₁ is selected from the group consisting of —CH₂OH and —CH₂CH₂CH₂CH₂NH₂, and R is selected from the group consisting of monovalent organic acid, ether and alkyl radicals containing from 6—30 carbon atoms and having at most two unsaturated bonds.

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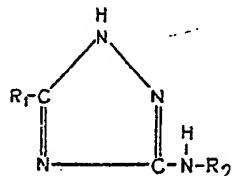
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O. Compounds having the following generic formula:



wherein R is an alkyl radical containing 6—30 carbon atoms and having at most two unsaturated bonds.

IV. Compounds wherein the substituted ring has from 4—8 atoms including three or more heterocyclic atoms. Compounds in this group include, without limitation, those having the following ring structures: furazan, oxadiazole, oxadiazoline, thiadiazole, thiadiazoline, triazole, triazoline, oxadiazine, thiadiazine and triazine. Typical compounds included in this group, for example, are the alkyl-substituted 1,2,4-triazoles having the following generic formula:



wherein R₁ in this case is selected from the group consisting of —H, —CH₃, and —CH₂OH and R₂ in this case is an alkyl radical containing 6—30 carbon atoms and having at most two unsaturated bonds.

V. Miscellaneous compounds having a structure as defined herein and operable in the process of the invention include, for example, copolymers of hydrophobic monomers such as stearyl methacrylate with monomers whose molecular structures incorporate the aforementioned structural criteria such as vinyl sorbitan, vinyl glucose and vinyl imidazoline.

The above types of compounds are only a few of the many types of compounds that can be used as volatilization inhibitors in the storage of volatile organic materials due to having the desired molecular configurations containing the head, tail and joiner hereinbefore described.

Thus, the following examples are intended to illustrate the applicability and modes of carrying out the invention but, as suitable variations will be apparent to those skilled in the art, they are not to be considered as limiting. In each of the examples, where pertinent, the weight of the empty cup was subtracted from the total weight of the cup containing the mixture. The cups used in the examples were, in each case, open aluminum cups two inches high with a horizontal cross-sectional area of 3—1/2 square inches.

EXAMPLE 1.

.10 grams of Arlacel 60 (sorbitan monostearate, manufactured by Atlas Powder Co.) was added to 10 grams of diethyl ether and placed into an open aluminum cup. Into another cup there were placed 10 grams of pure diethyl ether. Both cups were placed in open air and periodic weighings as shown below were taken of both cups.

The weights, at various times after beginning the test, were as follows:

	Time (Hours)	No Additive	Additive
	0	10.00 grams	10.00 grams
	1	5.31	8.76
	2	2.75	7.50
	3	.85	6.55
	4	.00	5.95
	24	—	5.20
	48	—	4.60

The pure diethyl ether sample contains some atmospheric water of condensation caused by the decrease in temperature by means of rapid evaporation. Thus as seen by the above chart, the evaporation rate of diethyl ether was greatly reduced by addition of only 1% sorbitan monostearate.

EXAMPLES 2 and 3.

Two 9.9 gram samples of methyl alcohol were combined with .1 gram of sorbitan monopalmitate in the one sample and sorbitan monostearate in the other (Arlacel 40

5 and 60, respectively, manufactured by the Atlas Powder Co.) and each sample was placed in an open aluminum cup. Another 10 gram sample of unmodified methyl alcohol was placed in an open aluminum cup. The aluminum cups are placed in open air at a temperature of 23—27° C. and the following periodic reading of the weight of each cup was taken:

5

Time (Hours)	Na Additive	Arlacel 60	Arlacel 40
0	10.00 grams	10.00 grams	10.00 grams
4	.50	8.50	8.01
8	.00	7.75	7.05
24	—	5.98	5.70

Thus, it is seen from the above chart that the addition of these materials greatly inhibits the evaporation of methanol.

EXAMPLE 4.

10 .3 grams of sorbitan monostearate were added to 9.7 grams of toluene and the resultant mixture was placed in an open aluminum cup. Into another cup there were placed 10 grams of toluene. Both the cups were placed in open air at 27° C. and the following periodic readings of the weight of each cup were taken:

10

Time (Hours)	No Additive	Additive
0	10.00 grams	10.00 grams
1	8.65	9.98
2	7.58	9.97
3	6.75	9.97
4	5.90	9.96
8	5.25	9.95
16	.51	9.93
24	.00	9.92
48	—	9.89
96	—	9.86
2 weeks	—	9.75

15 By plotting the weight against the time and determining the slope of the line it is seen that the steady-state evaporation rate of the sorbitan monostearate-modified toluene mixture is approximately .18%/day compared with a value of approximately 100%/day for the pure toluene.

15

EXAMPLES 5—16.

20 A series of sorbitan monoesters of fatty acids are tested for their effect on the evaporation rate of benzene in the same manner as Example 2, utilizing .1 grams of the sorbitan monoester indicated below and 10 grams of benzene. A 10 gram sample of pure benzene was placed in an aluminum cup. This was placed under the same conditions as the benzene samples containing the below sorbitan monoester outlined in Example 2 so as to supply a control. The relative observed results were as follows:

20

25

25

Example	Monoesters	Ranking*
5	Butyrate	
6	Isovalerate	
7	Caproate	1
8	Caprate	
9	Laurate	
10	Myristate	2
11	Palmitate	
12	Stearate	
13	Arachidate	3
14	Behenate	
15	Lignocerate	
16	Cerotate	2-3

*1. Somewhat better than the benzene control (10—20% retention of benzene in solution after 24 hours for a 1% solution. NOTE: Pure benzene completely evaporated in 4 hours under the same conditions.

2 Intermediately effective; retention of benzene in solution is 20—50% after 24 hours at room temperature.

3 Superior: Retention of benzene in solution is 50—99% after 24 hours at room temperature. Maximum values were obtained with the stearate.

EXAMPLE 17.

.1 gram of sorbitan monostearate was dissolved in 9.9 grams of benzene and left open to the air in an open aluminum cup. A similar container with 10 grams benzene containing no sorbitan monostearate is placed next to it. The latter completely evaporated in 4 hours, but the sorbitan monostearate solution lost only 23% by weight after 3 weeks' storage under the same conditions. When an open flame was played immediately above the surface of sorbitan monostearate solution, the latter did not ignite until stirred, at which point it burned with a steady flame which was extinguished merely by cessation of stirring.

5

10

15

20

25

EXAMPLE 18.

In order to determine the effect of various concentrations of sorbitan monostearate in benzene, 10 gram samples of benzene containing 0, .025, .05, .1, and .5 grams of the additive are prepared in the manner of Example 1 and placed in aluminum cups. The cups are placed in the open air and weighed periodically, giving the results which are tabulated in Figure 1.

As shown in Figure 1 the curve of the .25% sample levels off at a steady state evaporation rate when the weight is 60% of the original and since the samples containing .25, .5, 1.0 and 5. grams of sorbitan monostearate lose only 5—10% of their weight through evaporation, it is deduced that the critical concentration for use in benzene is approximately .5%. The steady-state evaporation rate of benzene containing over .5% sorbitan monostearate is .0025 g/hr./sq. in., as contrasted with a value of .6 g./hr./sq. in. for unmodified benzene.

The control of ignition also seems to parallel the above, since the sample containing .25% sorbitan monostearate is initially explosive; but, after 4—6 hours, it exhibits steady burning only on stirring.

In the above curves, it can be noted that diffusion of an effective concentration of additive to the benzene surface requires a finite period of time. This period has been determined to be relatively short.

EXAMPLES 19—20.

Styrene, toluene, and xylene are substituted for benzene in Example 17 and the same results are obtained, except that the rates of evaporation are even lower.

EXAMPLE 21.

- 5 10 grams of pure benzene are placed in an open aluminum cup whose sides contain small holes. The results of periodic weighing after the cup is placed in open air are given below. Next, the cup is cleaned and then 9.9 grams of benzene containing .1 of sorbitan monostearate are introduced into the same cup, which was placed in open air and weighed at intervals. The results of periodic weighing, as shown below, indicate that leakage was inhibited almost completely in the sample containing the sorbitan monostearate. 5
10

Time	No additive	Additive
0 minutes	10.00 grams	10.00 grams
1	6.61	10.00
5	1.75	10.00
7	.96	10.00
15	.00	9.99
60	—	9.83
2 hours	—	9.74

Since the same container was used, there is no doubt that the sorbitan monostearate was responsible for this improvement.

EXAMPLE 22.

- 15 A solution of .5 parts of sorbitan monostearate is added to 9.5 parts of benzene and placed in an open container. This mixture is used to degrease an oil-coated metal transmission gear. Before and after immersion of the gear into the solution, the solution is non-flammable. The solution is agitated and ignited at the time of entry of the gear into the solution. The solution burns with a steady flame which constantly has to be reignited and which extinguishes itself as soon as agitation ceases. The gear is found to be at least as clean as when trichloroethylene is used. 15
20

- 25 The above solution is also used to dry-clean the jacket of a cotton suit. The garment is removed from the solution devoid of grease and dirt. Again, the benzene solution burns only during agitation and is relatively non-flammable otherwise. Because of the relatively large surface areas exposed, the solution does evaporate from the garment and is flammable at this point. However, the primary danger of explosion or ignition of the material in bulk has been eliminated. 20
25

EXAMPLES 23—24.

- 30 10 grams of Vibrin (Registered Trade Mark) 158A (a polyester resin containing styrene; manufactured by the Naugatuck Chemical Division of U.S. Rubber Co.) are weighed out into each of three open aluminum cups and .1 gram of sorbitan monostearate is placed in one cup, .25 grams of sorbitan monostearate is placed in the other cup, and the third is used as a control. The samples are placed in open air and weighed periodically with the following results (weight remaining). 30
35

Time	0%	1.0%	2.5%
15 minutes	9.3 grams	9.99 grams	10.00 grams
45	9.81	9.96	9.98
90	9.70	9.93	9.95
2 Hours	9.61	9.89	9.92
4	9.45	9.79	9.87
24	9.16	9.63	9.77
48	7.85	9.48	9.48

EXAMPLE 25.

Ten grams of Vibrin 158A (Manufactured by Naugatuck Chemical Division of U.S. Rubber Co.) are catalyzed with .1 gram of benzoyl peroxide and .08 gram of Promoter #1 (Manufactured by Naugatuck Chemical Division of U.S. Rubber Co.) and are combined with 4 grams of chopped glass fibre and placed in a mold whose surface temperature is maintained at 80° C. This material gels in 10 minutes, and after prolonged heating, it remains tacky, fragile and friable. It is observed that the styrene has evaporated, leaving the resin so depleted in styrene that it cannot be cured adequately.

.1 gram of sorbitan monostearate is added to the above composition, and the above steps are repeated. The plastic mass gels in 10 minutes, and on further heating it forms a fully cured, filled polyester article. Thus by the elimination of styrene evaporation with sorbitan monostearate, the polystyrene resins are easily cured, after forming, on contact with an open, heated mold.

EXAMPLE 26.

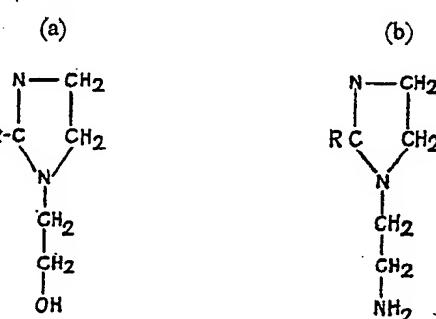
Ten grams of carbon tetrachloride with and without .1 gram of sorbitan monostearate are weighed out into open aluminum cups which are placed in open air. Periodic weighings of both cups reveal the following data:

Time (Hours)	No additive	Additive
0	10.00 grams	10.00 grams
½ hour	8.51	9.95
1	6.10	9.75
2	2.98	9.52
3	.25	9.15
8	.00	8.73
24	—	8.12

EXAMPLE 27.

.5 grams of tetrahydrofurfuryl palmitate is added to 10 grams of n-heptane in an aluminum cup and placed in the open air. An identical quantity of n-heptane is placed in another aluminum cup having the same dimensions and placed in the open air. The n-heptane evaporates completely in 1—2 hours while the sample containing the tetrahydrofurfuryl palmitate loses only 40% of its weight after 4 days.

EXAMPLES 28—29.
Nalcamines G—14 and G—34 (manufactured by Nalco Chemical Co.) are fatty imidazoline mono- and di-amines having the structures:



wherein R is a stearyl radical. Two samples are prepared by adding .1 gram of each of these compounds to two samples containing 10 grams methanol in open aluminum cups. The cups are placed in the open air. The steady state rate of evaporation of pure methanol is 33%/hour. The steady state evaporation rates of the modified samples are:

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15

- a) 1% stearyl imidazoline monoamine: .021%/hour.
b) 1% stearyl imidazoline diamine: .027%/hour.

EXAMPLES 30—31.

5 10 grams of benzene is modified by addition of .1 grams of dodecylurea-N¹glucoside.

5

Another sample is prepared by adding .05 grams of dodecylurea-N¹glucoside to 10 grams of benzene. The samples are placed in aluminum cups and a control is also prepared. The samples are placed in open air and the results are shown in Figure 2.

10

The steady state evaporation rate (measured in the interval "A") (as shown in Figure 2) is .16%/hour in contrast to an average value of 25%/hour for pure benzene.

10

When a 1% composition of the above glucoside in a dry cleaning solvent such as trichloreoethylene, carbon tetrachloride, ethylene dichloride, dichloroethylene and other conventional dry cleaning solvents is used to dry-clean one half of a soiled shirt collar, it is found to be much more effective than an unmodified dry-cleaning solvent (which is used on the other half), and to be non-flammable while in bulk. Because of the large surface area of the cleaning solution which was exposed during drying of the garment, the solution on the garment was found to be flammable. However, during bulk operation the solution lost its inflammability.

15

20 EXAMPLE 32.
Sucrose di-stearate (manufactured by Colonial Sugar Co.) is added in various concentrations to benzene in the manner of Example 28. The curves of weight % retained versus time are similar to those shown in Figure 2, except that the steady state time rate of evaporation is .19%/hour.

20

25 EXAMPLES 33—37.
A mixture of glucose monostearate and fructose monostearate are prepared by hydrolysis of sucrose di-stearate. This mixture is highly effective in reducing the evaporation rates of benzene, trichloreoethylene, styrene, methanol, and diethyl ether. The 1% solutions have steady state evaporation rates of .12%/hour, 10%/hour, .06%/hour, .17%/hour, and .36%/hour respectively.

25

30 EXAMPLE 38.
35 Stearyl glucose ether is prepared by the method outlined in U.S. patent 2,974,134. This material is effective in inhibiting the evaporation of volatile organic liquids. In 1% solution in benzene tested in the manner of Example 28 the steady state evaporation rate is reduced to a value of .29%/hour from a value of 25.00%/hour for the pure benzene.

30

EXAMPLES 39—46.

35 To determine the effect of degree of esterification on the utility of di-saccharide esters as evaporation retardants, the following experiment was performed; 3% of each additive was dissolved in 10.0 grams of benzene and allowed to evaporate from an open aluminum cup. The amounts remaining after 5 and 15 hours are given below.

35

40

Example	Additive	Grams Remaining After	
		5 Hours	15 Hours
Control	None	0.00	0.00
39	Sucrose Monopalmitate	1.76	0.00
40	Sucrose Monostearate	2.21	0.00
41	Sucrose Monoarachidate	2.00	0.00
42	Sucrose Monooleate	1.05	0.00
43	Sucrose Dipalmitate	7.95	7.53
44	Sucrose Distearate	9.01	8.81
45	Sucrose Diarachidate	8.97	8.81
46	Sucrose Dioleate	7.56	5.63

Since all of the above were performed concurrently, conditions of temperature, humidity, and atmospheric pressure were identical. Thus, it can be seen that, although the monoesters do decrease the evaporation rate of benzene to some extent, they are inferior to the diesters. Likewise, the compounds having straight-chain "tails" (palmitate, stearate, and arachidate) are superior to the one containing an unsaturated "tail" (oleate). 5

EXAMPLES 47—48.

N-hydroxy ethyl piperazine is reacted with hexadecyl isocyanate. The resulting product is effective in reducing the volatility of organic liquids and is especially effective when used as an additive to acetone and methyl ethyl ketone. 10

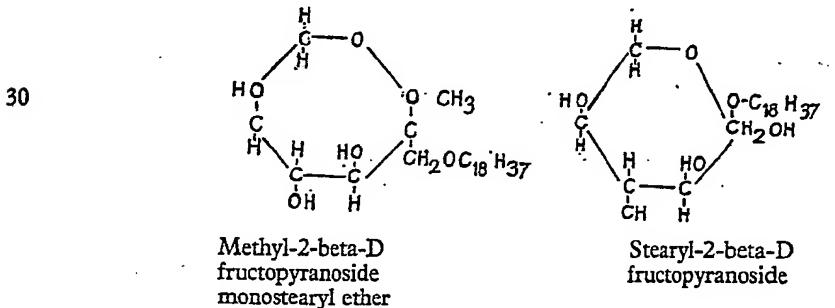
EXAMPLES 49—51.

N-(aminopropyl) morpholine is reacted with stearoyl chloride and the product is screened for use as a volatility depressant. Although it is effective when added to non-polar organic liquids, it is found to be extremely effective in decreasing the volatility of alcohols such as methanol, ethanol, and isopropanol. For example, with isopropanol, the steady state evaporation rate is .17%/hour, as contrasted with a value of 29.00%/hour for pure isopropanol tested under the same conditions as Example 38. 15

EXAMPLES 52—55.

In order to evaluate alpha-D-pyranose esters, 1 mole of the following sugars are reacted with 1 mole of stearoyl chloride in a dilute di-methyl sulfoxide solution: glucose, mannose, allose, and galactose. Although all are successful in inhibiting the evaporation of benzene, the glucose and allose esters are most satisfactory. In these cases, the % weight loss of 1% benzene, tested under the same conditions as Example 38 solutions after 4 days is 8—12%. The steady state evaporation rates (measured in the 10—20 hour interval) are .10 and .07%/hour. These might be contrasted with the average evaporation of benzene which is 25.00%/hour (measured under the same conditions). 20

EXAMPLES 56—57.



1 gram of the above compounds are added to separate cups each containing 10 grams of benzene. The above compounds both yield a steady state evaporation rate of .26%/hour, as contrasted with a 25.00%/hour for pure benzene. 30

EXAMPLE 58.

Beta resorcyclic acid is reacted with stearyl alcohol to form a semi-solid product, one gram of which is then added to 10 gram of benzene as a volatility depressant. The sample is tested in the manner outlined in Example 1. The steady state evaporation rate is measured to be .49%/hour as contrasted with a value of 25.00%/hour for pure benzene. 35

EXAMPLES 59—60.

Dihydroascorbyl stearate is added in various amounts to 10 grams of benzene. The test conditions are the same as in Example 38. The effects on evaporation are given in Figure 4. The steady state evaporation rates are .32%/hour and .39%/hour for the solutions containing 2.5% and 1.0% of dihydroascorbyl stearate. 40

EXAMPLE 61.

Pyridyl glycol stearate is added to a variety of organic liquids and is found to be effective in retarding evaporation. At a 1% concentration in 10 grams of benzene, tested by the procedure outlined in Example 1, the evaporation loss after 4 hours' 45

storage was 2.5% versus 100% for unmodified benzene tested under identical conditions.

EXAMPLE 61—A.

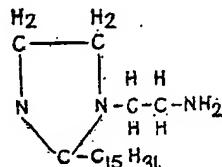
.1 gram of dodecyl succinic anhydride is added to 10 grams of benzene in an aluminum cup. The cup is placed in the open air. The evaporation of benzene after 4 days is found to be negligible.

5

10

20

EXAMPLES 62—72.
1 gram of an alkyl imidazoline amine having the formula:



10 is added to 10 grams of methanol in an open aluminum cup. The cup is placed in the open air at a temperature of 23—27° C. as in the other open air tests. For the above ester, the steady state evaporation rate was .25%/hour.

Utilizing the same procedure as above and also other alkyl substituted imidazoline amines it was found that the steady state evaporation was as follows:

Example	Alkyl group	Steady State Evaporation Rate for Methanol
62	C ₂₄ H ₄₉	.75%/hour
63	C ₂₀ H ₄₁	.22%/hour
64	C ₁₉ H ₃₉	.23%/hour
65	C ₁₇ H ₃₅	.24%/hour
66	C ₁₅ H ₃₁	.25%/hour
67	C ₁₃ H ₂₇	.28%/hour
68	C ₁₁ H ₂₃	.33%/hour
69	C ₉ H ₁₉	.33%/hour
70	C ₇ H ₁₅	.33%/hour
71	C ₅ H ₁₁	.46%/hour
72	C ₃ H ₇	1.12%/hour

EXAMPLES 73—122.

Samples are made up using 10 grams of the below mentioned organic solvents and 1 gram of the following additives. Each sample is placed in a separate open aluminum cup and the cups are then placed in the open air where they are tested as above.

20

20

The additives chosen are the following:

- A) Sorbitan monostearate
- B) Stearyl imidazoline diamine

Example	Organic Solvent A	B
73 — 74	Acetaldehyde	E
75 — 76	Acetone	E
77 — 78	Acetonitrile	E
79 — 80	Acrolein	G
81 — 82	Allyl Chloride	G
83 — 84	Benzene	E
85 — 86	Cyclohexane	E
87 — 88	Diethyl amine	G
89 — 90	Diethyl ether	G
91 — 92	Dioxane	E
93 — 94	Epichlorohydrin	E
95 — 96	Ethanol	E
97 — 98	Ethyl Acetate	E
99 — 100	Ethyl Chloride	E
101—102	Furan	E
103—104	Heptane	E
105—106	Isopropanol	E
107—108	Methanol	E
109—110	Methyl ethyl ketone	E
111—112	Methyl formate	E
113—114	Propylene oxide	E
115—116	Toluene	E
117—118	Trichloro ethylene	E
119—120	Trimethyl amine	E
121—122	Vinyl acetate	G

With each pure solvent, the time required for evaporation (100% weight loss) is determined. The additive (1% concentration) was then characterized as E, excellent (0—15% weight loss in the same time); G, good (15—50% weight loss); or F, fair (50—75% weight loss), depending on the weight loss of a 1% solution in that solvent at that time.

EXAMPLE 123.

Ten grams of Ucon (Trade Mark) Refrigerant #11 (CCl_2F) manufactured by Union Carbide Chemical Co.) were weighed out into an aluminum cup. A similar sample containing ten grams of Ucon Refrigerant #11 and 1 gram of sorbitan monostearate is prepared in the same manner and both samples are placed in the open air. Periodic weighings reveal that the modified material evaporates at a rate of less than 2% that of the unmodified CCl_2F . Also, it is noted that the temperature drop due to evaporation could be controlled merely by agitation; thus, the CCl_2F containing 1% of sorbitan monostearate and having an original temperature of $25.8^\circ C.$, evaporated readily when stirred and its temperature dropped to $10.2^\circ C.$ but the evaporation decreased immediately on cessation of agitation and the temperature reverted to its former value of $25.8^\circ C.$ At the latter point, the evaporation-impeding microsheath has "mended" itself and therefore retained its effectiveness. In effect, the use of the additive enables the control of refrigeration systems by mechanical means.

EXAMPLE 124.

.1 gram of Atlas 20—18 (a mixture of sorbitan monostearate and ethoxyethylated sorbitan monostearate manufactured by Atlas Chemical Co.) was added to 10 grams of methanol which was placed in an open aluminum cup. Into another cup is placed 10 grams of pure methanol. The cups were tested in the manner of Example 1 with the following results:

Time (Hours)	No additive	Additive
0	10	10
4	50	9.5
8	00	8.55
24	—	7.7

The evaporation-retarding effectiveness of a compound in accordance with the invention varies with the nature of the material to which it is added. It is believed that among the factors determining the effectiveness of a given system are the dipole moment, boiling point and heat of vaporization of the volatile organic liquid and the hydrophile-lipophile balance and "head" symmetry of the compound. It has been found that for this reason, mixtures of compatible liquids having dissimilar polarities could be resolved into their components by addition of such a compound.

EXAMPLES 125—126.

On adding 1% of sucrose dipalmitate to a 50:50 mixture of benzene and methanol and then allowing the mixture to remain exposed to the atmosphere for 5 hours, the final remaining solution was found to contain 90% benzene and 10% methanol.

Likewise, when the above process was repeated with an azeotropic mixture of benzene and ethanol, the final product was found to be enriched by a factor of 300% in benzene; i.e., the benzene percentage concentration in the final composition was three times that of the original azeotropic composition.

Thus, it is seen that both azeotropic and non-azeotropic mixtures can easily be fractionated in accordance with the invention.

As may be seen from the results reported in Examples 125—126 one may, in accordance with the invention, separate one volatile organic liquid from another volatile organic liquid by providing a mixture of said liquids, adding a compound in accordance with the invention, placing the mixture in a container, providing a free liquid surface on said mixture in said container then allowing the mixture to evaporate to provide a mixture remaining in said container which is rich in said liquid of which evaporation is inhibited. One may, if desired, condense in a separate receptacle the material which is evaporated from said mixture and the condensed material is of course then a condensed separated mixture which is rich in the evaporated and condensed liquid.

The results reported in Example 123 make it clear that there is provided a new method of controlling refrigeration rates within the scope of the invention. Thus, to maintain an article at a certain temperature an open container is placed in contact with the article, the container is filled with a suitable volatile organic liquid, preferably one selected from a group consisting of chlorinated, fluorinated and brominated hydrocarbons containing one to three carbon atoms such as particularly difluorotetra-chlorethanes, trifluorochloromethanes and ethyl chloride and then a compound in accordance with the invention is added and the mixture stirred. By controlling the rate at which it is stirred it is possible to control the rate at which the volatile material evaporates and the rate of evaporation of the volatile material controls the rate at which the container and consequently the article adjacent to the container is cooled. Refrigeration may be stopped by stopping the stirring; it may be started again by starting to stir again. When stirring is stopped evaporation entirely stops and consequently refrigeration stops. The invention may be utilized in a mechanical refrigerator by causing the portion of the container which is above the free surface of the liquid to be in communicating relation with a condenser and compressor so that when it is desired to cause refrigeration to take place, the material is agitated, as by operating a stirrer in the material, or applying means to cause it to vibrate, to cause evaporation of the volatile material to take place. The volatile material is then condensed, compressed and may be recycled to the container where evaporation can again take place.

In accordance with the invention the active life of a large number of active volatile organic materials may be prolonged or increased. Thus, moth repellants, by reason of inhibition of the operation of the repellent in accordance with the invention, last longer and operate for a longer time, that is have a longer active life. A com-

5 pound in accordance with the invention may be added to a liniment or rubbing alcohol so that when the liniment or rubbing alcohol is applied to the human body it does not evaporate so quickly but has a longer active life and is active for a longer time in its effect on the body.

5 It is often desirable to provide a material which is at least partially a solvent for paints and varnishes, which will have a longer active life. Thus paint-brush cleaners and paint removing or stripping compositions often evaporate relatively quickly and thus lose their effectiveness relatively quickly. In accordance with the invention the active life of such materials may be prolonged.

10 Examples 23—25 describe the making of solid polymeric articles comprising providing a mixture of an adduct of a polyhydric alcohol and a polycarboxylic acid with a volatile organic ethylenically unsaturated polymerizable material and a compound in accordance with the invention, then placing such mixture in a mold and polymerizing it in the mold. A similar practice may be carried out in accordance

15 with the invention wherein such a mixture is sprayed against a mold which has been previously heated. Heat is transferred from the mold to the mixture to provide heating of the mixture in order to cause the mixture to become cured. This process has not heretofore been commercially feasible due to the tendency towards flash evaporation of the ethylenically unsaturated cross-linking agent which is provided

20 in such polyester compositions; such relatively rapid evaporation causes the final polymer to have an inadequate amount of such ethylenically unsaturated material in it, with a consequent deleterious effect on the properties of the resultant polymeric article. Suitable ethylenically unsaturated polymerizable materials for use in these processes are described in the book "Polyesters and Their Applications" by Bjorksten,

25 Tovey, Harker and Henning, Rheinhold Publishing Corporation, New York, 1956. Almost any ethylenically unsaturated monomer is suitable. Such monomers which are preferred include styrene, methylstyrene, divinylbenzene, stilbene, vinyl acetate, diallyl and dimethallyl esters of maleic, fumaric, succinic, itaconic and adipic acids and esters of acrylic and methacrylic acids containing 4 to 11 carbon atoms.

30 A similar practice may be utilized to provide a destaticized plastic article. When a compound in accordance with the invention is added to a volatile organic pre-polymeric polymerizable material and the resultant mixture is then polymerized to provide a solid polymeric article, the article is relatively free from tendency to accumulate static charge. Alternatively, a destaticized plastic article may be provided by adding to a hot melted liquid (normally solid) polymeric material, a compound 35 in accordance with the invention and then placing the mixture in a mold and then cooling it in the mold to provide such an article.

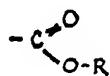
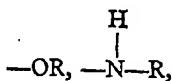
35 As indicated in Example 22, greasy metal parts may be dipped into a mixture provided in accordance with the invention, of which the evaporation has previously been inhibited during storage, and after the greasy metal parts are dipped in the mixture, they may be removed from the mixture and then residual amounts of such mixture which adhere to the previously greasy parts (from which grease will have been found to have been removed) may be removed by drying.

40 All steps reported herein are carried out at a temperature (ambient) of from 45° F. to 95° F. unless otherwise specifically stated.

45 It may thus be seen that the invention is broad in scope and includes such modifications as will be apparent to those skilled in the art and is to be limited only by the claims.

50 **WHAT WE CLAIM IS:—**

55 1. A method of storing volatile organic material so as to inhibit volatilization of said organic material during storage comprising adding to a volatile organic material, in the amount of .005% to 10% by weight of said material, a compound whose molecular configuration comprises at least one head and at least one tail, said head comprising a ring of four to eight atoms, said atoms which form the ring within the head being carbon with or without oxygen, nitrogen or sulfur, each ring within said head having substantially only one tail portion, comprising aliphatic radicals as hereinbefore defined containing from 6 to 30 carbon atoms and having at most two unsaturated bonds, said head and said tail being joined so that said tail is free to rotate with respect to said head, said head comprising at least one of the polar groups



5 $-\text{N}=\text{N}-\text{R}$, $-\text{O}-$, NO_2 , sulfate, sulfonate, phosphate, phosphonate, mercaptan and thioacid, wherein R is hydrogen or a saturated or unsaturated hydrocarbon radical containing from 1 to 5 carbon atoms.

10 2. A method of cleaning objects comprising adding to a volatile organic solvent cleaning material in the amount of .005% to 10% by weight of said material a compound whose molecular configuration comprises at least one head and at least one tail, said head comprising a ring of four to eight atoms, said atoms which form the ring within the head being carbon, with or without oxygen, nitrogen and sulfur, each ring within said head having substantially only one tail portion, said tail being a straight chain hydrocarbon radical containing from 6 to 30 carbon atoms and having at most two unsaturated bonds, said head and said tail being joined so that said tail is free to rotate with respect to said head, said head comprising at least one

15 polar group, consisting of $\begin{array}{c} \text{H} \\ | \\ -\text{OR}, -\text{N}-\text{R}, \end{array}$

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20 $-\text{N}=\text{N}-\text{R}$, $-\text{O}-$, NO_2 , sulfate, sulfonate, phosphate, phosphonate, mercaptan and thioacid, wherein R is hydrogen or a saturated or unsaturated hydrocarbon radical containing from 1 to 5 carbon atoms, placing the resultant mixture in a container, placing the objects to be cleaned in said material, removing them therefrom and then drying the objects.

25 3. The method of forming a plastic article comprising adding to a volatile organic prepolymeric polymerizable material, in the amount of .005% to 10% by weight of said material, a compound whose molecular configuration comprises at least one head and at least one tail, said head comprising a ring of four to eight atoms consisting of carbon with or without oxygen, nitrogen and sulfur, each ring within said head having substantially only one tail portion, said tail consisting of a long chain hydrocarbon radical containing from 6 to 30 carbon atoms and having at most two unsaturated bonds, said head and said tail being joined so that said tail is free to rotate with respect to said head, said head comprising at least one polar

30 group, consisting of $\begin{array}{c} \text{H} \\ | \\ -\text{OR}, -\text{N}-\text{R}, \end{array}$

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35 $-\text{N}=\text{N}-\text{R}$, $-\text{O}-$, NO_2 , sulfate, sulfonate, phosphate, phosphonate, mercaptan or thioacid, wherein R is hydrogen or a saturated or unsaturated hydrocarbon radical containing from 1 to 5 carbon atoms, and polymerizing said material to provide a solid polymeric article.

4. A method according to claim 3 wherein said polymerizable material is a mixture of an adduct of a polyhydric alcohol and a polycarboxylic acid with a volatile organic ethylenically unsaturated polymerizable material.

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5. The method of claim 4 wherein said volatile ethylenically unsaturated polymerizable material is styrene, methyl styrene, divinyl benzene, stilbene, vinyl acetate, diallyl or dimethallyl esters of maleic, fumaric, succinic, itaconic or adipic acids or esters of acrylic or methacrylic acid containing 4 to 11 carbon atoms.
6. The method of claim 1 wherein said volatile organic material is a moth repellant.
7. The method of claim 6 wherein said moth repellent is naphthalene or p-dichlorobenzene.
8. The method according to claim 1 wherein said volatile organic material is a liniment.
9. The method according to claim 8 wherein said volatile organic material is rubbing alcohol.
10. The method according to claim 1 wherein said volatile organic material is at least partially a solvent for paint and varnish coating substances, comprising the additional step of applying said material to an article to be coated therewith.
11. The method according to claim 10 comprising the additional step of applying said material to an article having such substance at least partially dried thereon.
12. The method according to claim 11 wherein said material is a paint brush cleaner.
13. The method according to claim 11 wherein said material is a paint and varnish stripper.
14. A method according to claim 1 of separating one volatile organic liquid from another volatile liquid comprising the additional steps of placing the resultant mixture in a storage container, providing a free liquid surface on said mixture in said container, evaporating one of said liquids from said surface while inhibiting the evaporation of the other of said liquids with said compound, condensing the evaporated liquid in a separate receptacle to provide a condensed separated mixture which is rich in said evaporated and condensed liquid and a mixture remaining in said container which is rich in said liquid of which evaporation is inhibited.
15. The method according to claim 1 of refrigerating an article comprising the additional steps of placing the resultant mixture in a container, placing said container against said article, agitating said mixture to disturb the surface thereof thereby increasing the rate of evaporation thereby lowering the temperature of and cooling said container and said article in contact therewith, controlling the rate of agitation to control the rate of said cooling and ceasing said agitation to stop said cooling.
16. A process according to any one of claims 1 to 15 wherein said head is a sugar residue.
17. A process according to any one of claims 1 to 16 wherein the head is a monosaccharide residue.
18. A process according to any one of claims 1 to 16 wherein the head is a disaccharide residue.
19. A process according to any one of claims 1 to 15 wherein the head is a substituted ring of from 4 to 8 atoms having a single heterocyclic atom consisting of oxygen, nitrogen or sulfur.
20. A process according to any one of claims 1 to 15 and 19 wherein the head is oxetane, pyrrole, furan, thiophene, piperidine, pyridine, pyran, or thiapyran.
21. A process according to any one of claims 1 to 15 wherein the head comprises a ring having from 4 to 8 atoms including two heterocyclic atoms oxygen, nitrogen or sulfur.
22. A process according to any one of claims 1 to 15 and 21 wherein the head is oxazole, oxazoline, thiazole, oxathiole, dioxolane, imidazole, imidazolidine, pyrazoline, morpholine, or thiazine.
23. A process according to any one of claims 1 to 15 wherein the head comprises a ring having from 4 to 8 atoms including at least three heterocyclic atoms consisting of oxygen, nitrogen or sulfur.
24. A process according to any one of claims 1 to 15 and 23 wherein the head is a furazan, oxadiazole, oxadiazoline, thiadiazole, thiadiazoline, triazole, triazoline, oxadiazine, thiadiazine, or triazine nucleus.
25. A process according to any one of claims 1 to 24 wherein the tail has from 12 to 22 carbon atoms.
26. The method according to any one of claims 1 to 15 wherein said compound is an alkyl mono esters or alkyl mono ethers of sorbitan.
27. The method of claim 26 wherein said compound is sorbitan monostearate.
28. The method of claim 26 wherein said compound is sorbitan monobehenate.
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29. The method of claim 26 wherein said compound is sorbitan monopalmitate.
 30. The method of claim 26 wherein said compound is sorbitan monoarachidate.
 31. The method of claim 26 wherein said compound is sorbitan monomyristate.
 32. The method according to any one of claims 1 to 15 wherein said compound
 is a substituted imidazoline and said polar group is —CH₂CH₂NH₂ or CH₂CH₂OH. 5
33. The method of claim 32 wherein said tail is a stearyl radical.
 34. The method of claim 32 wherein said tail is a behenyl radical.
 35. The method of claim 32 wherein said tail is an arachydyl radical.
 36. The method of claim 32 wherein said tail is a palmityl radical.
 37. The method according to any one of claims 1 to 16 and 18 wherein said
 compound is a dialkyl ester or dialkyl ether of sucrose. 10
38. The method of claim 37 wherein said compound is sucrose distearate.
 39. The method of claim 37 wherein said compound is sucrose dipalmitate.
 40. The method according to any one of claims 1 to 16 and 17 wherein said
 compound is a mono alkyl ester or mono alkyl ether of a pyranose. 15
41. The method of claim 40 wherein said compound is glucose monostearate.
 42. The method of claim 40 wherein said compound is glucose monopalmitate.
 43. The method according to any one of claims 1 to 15, 19 and 20 wherein said
 compound is a fatty acid ester of a cyclic alcohol containing a saturated furan ring. 20
44. The method of claim 43 wherein said compound is tetrahydrofurfuryl
 palmitate.
 45. The method of claim 43 wherein said compound is tetrahydrofurfuryl
 stearate.
 46. The method of storing volatile organic material substantially as hereinbefore
 described. 25

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3 SHEETS

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SHEET 1

FIG. I

WT. REMAINING VS. TIME
FOR VARIOUS CONCENTRATIONS
OF SORBITAN MONO STEARATE
IN BENZENE

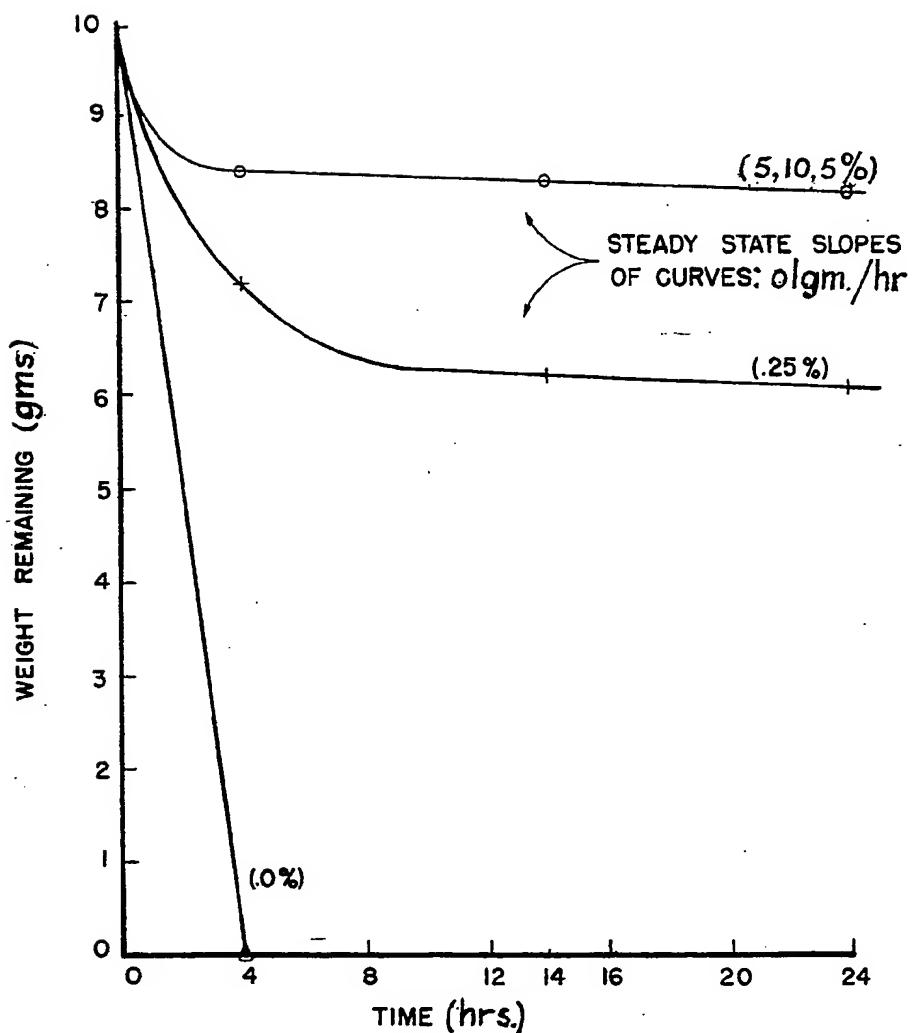
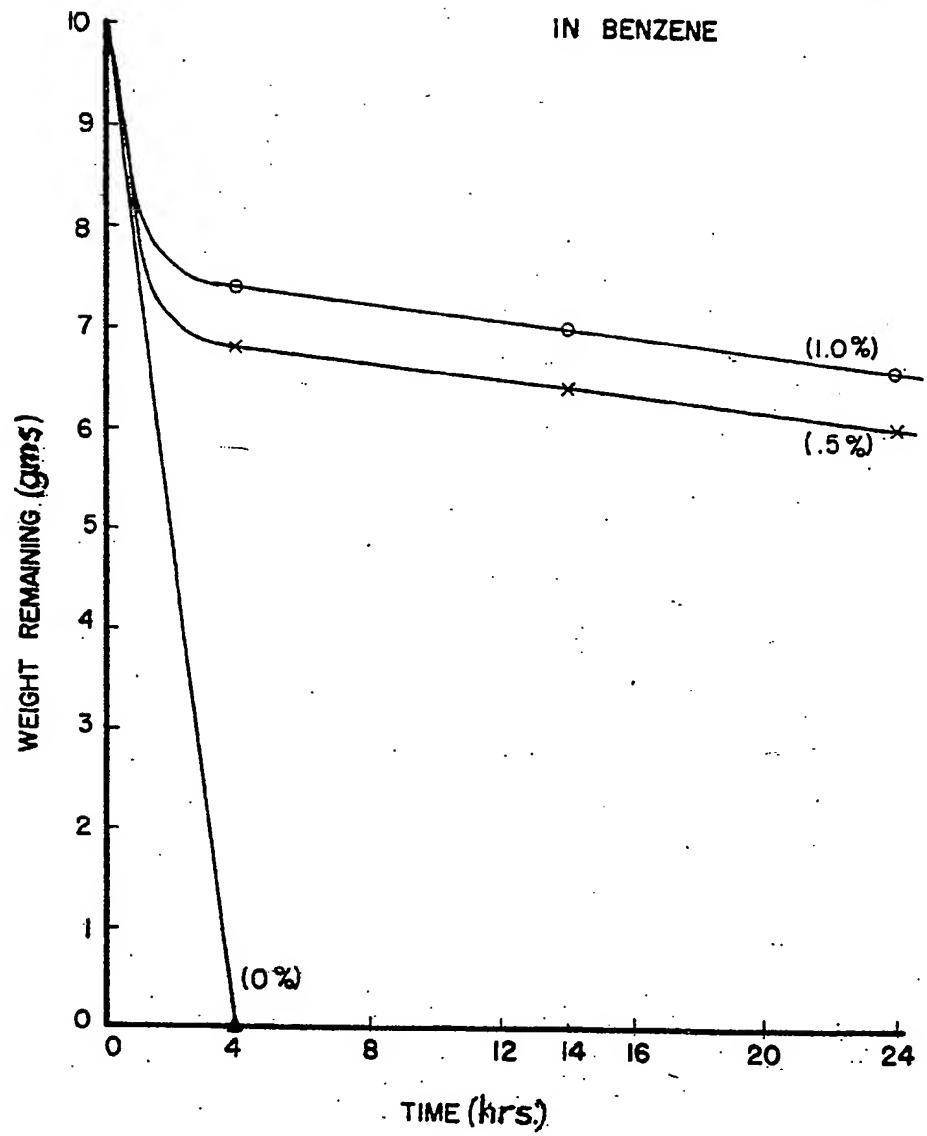


FIG. 2

WT. REMAINING VS. TIME
FOR TWO CONCENTRATIONS
OF DODECYL-N^L-GLUCOSIDE
IN BENZENE

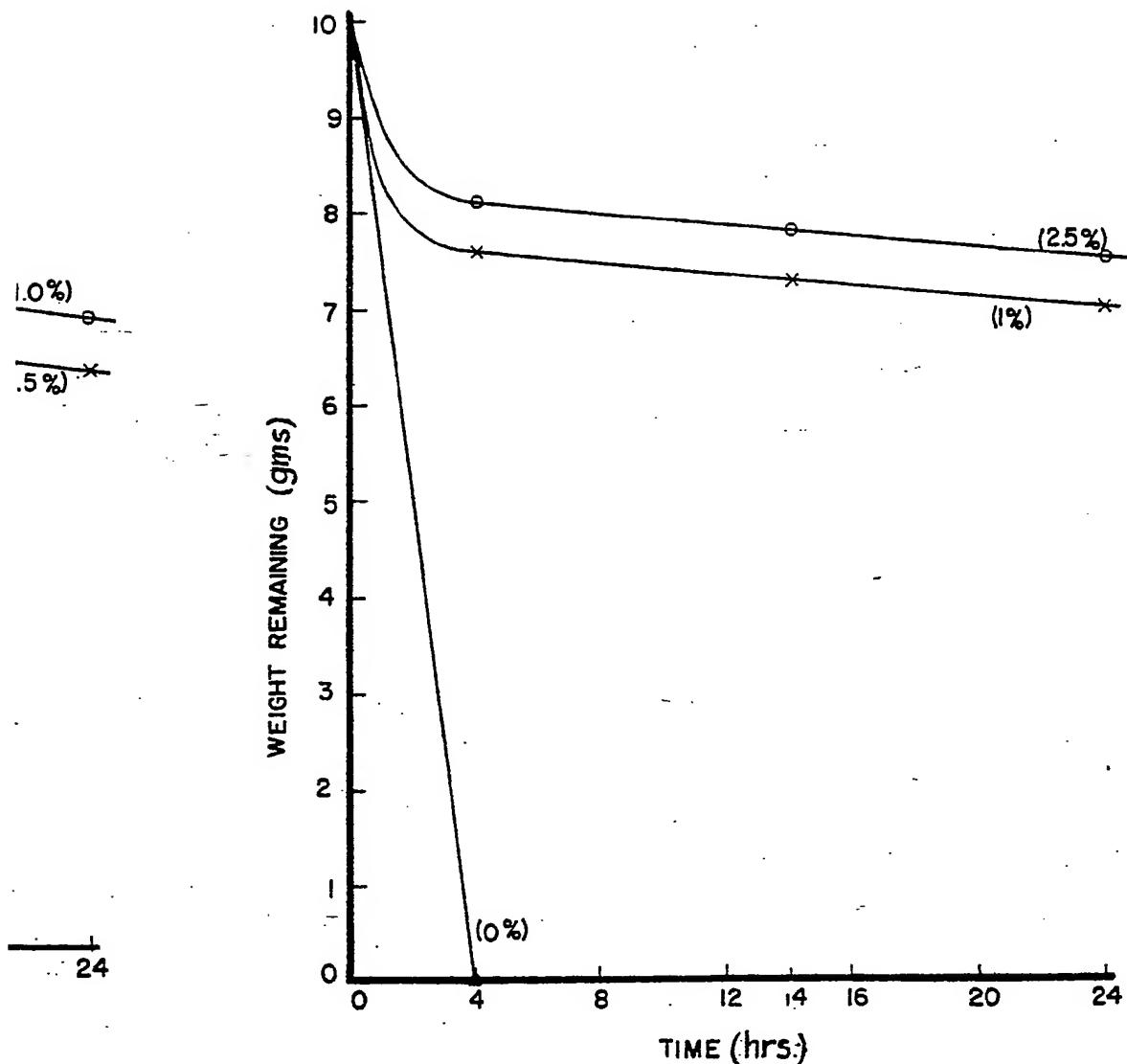


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SHEETS 2 & 3

FIG. 3

TIME
MATERIALS
COSIDE

WT. REMAINING VS. TIME
FOR BENZENE SOLUTIONS OF
DIHYDRO ASCORBYL STEARATE



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FIG. 2
WT. REMAINING VS. TIME
FOR TWO CONCENTRATIONS
OF DODECYL-N⁺-GLUCOSIDE
IN BENZENE

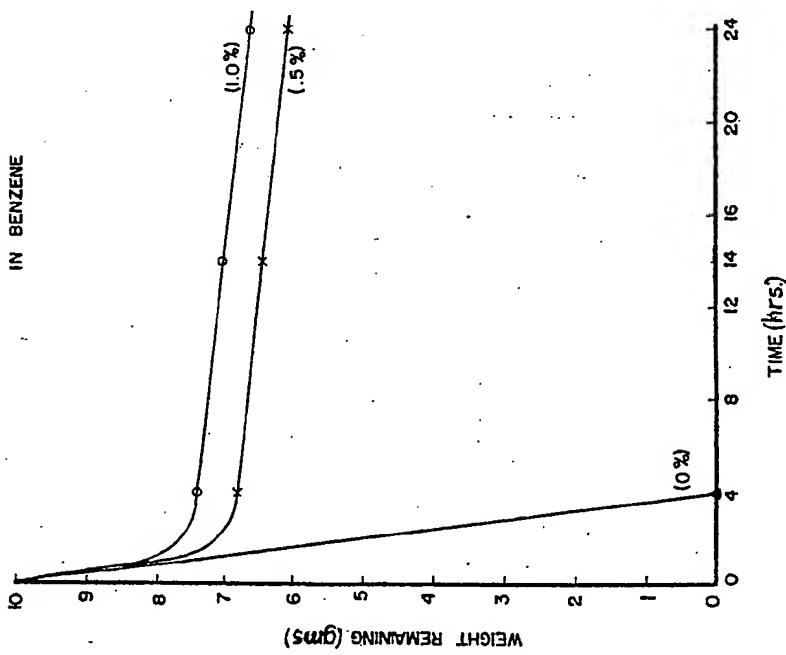
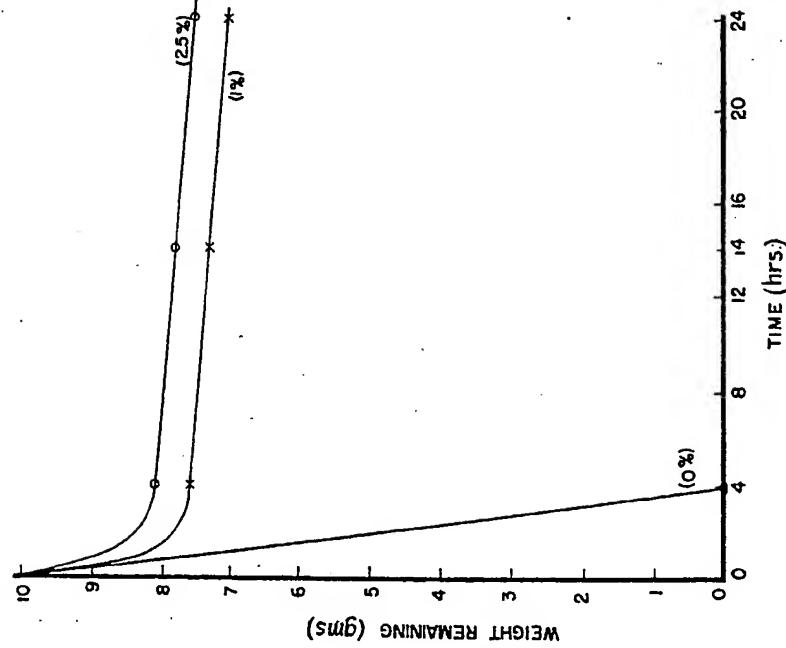


FIG. 3
WT. REMAINING VS. TIME
FOR BENZENE SOLUTIONS OF
DIHYDRO ASCORBYL STEARATE



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